

What is claimed is:

1. A monolithic ink-jet printhead, comprising:

a substrate having an ink chamber to be supplied with ink to be ejected, a manifold for supplying ink to the ink chamber, and an ink channel for providing communication between the ink chamber and the manifold;

a nozzle plate including a plurality of passivation layers sequentially stacked on the substrate, a metal layer formed on the plurality of passivation layers, and a nozzle, through which ink is ejected from the ink chamber, that penetrates the nozzle plate;

a heater provided between adjacent passivation layers of the plurality of passivation layers, the heater being located above the ink chamber for heating ink within the ink chamber;

a conductor provided between adjacent passivation layers of the plurality of passivation layers, the conductor being electrically connected to the heater for applying a current to the heater; and

a hydrophobic coating layer formed exclusively on an outer surface of the metal layer.

2. The printhead as claimed in claim 1, wherein the hydrophobic coating layer is made of a material having appropriate chemical resistance and abrasion resistance.

3. The printhead as claimed in claim 2, wherein the hydrophobic coating layer is made of at least one material selected from the group consisting of a fluorine-containing compound and a metal.

4. The printhead as claimed in claim 3, wherein the fluorine-containing compound is selected from the group consisting of polytetrafluoroethylene (PTFE) and fluorocarbon.

5. The printhead as claimed in claim 3, wherein the metal is gold (Au).

6. The printhead as claimed in claim 1, wherein the metal layer is made of a material selected from the group consisting of nickel (Ni) and copper (Cu).

7. The printhead as claimed in claim 1, wherein the metal layer is formed by electroplating to a thickness of about 30-100  $\mu\text{m}$ .

8. The printhead as claimed in claim 1, wherein the nozzle comprises:

a lower nozzle formed through the plurality of passivation layers; and  
an upper nozzle formed through the hydrophobic coating layer and  
the metal layer.

9. The printhead as claimed in claim 8, wherein the upper nozzle  
has a tapered shape in which a cross-sectional area decreases gradually  
toward an exit.

10. The printhead as claimed in claim 1, wherein the nozzle plate  
further comprises:

a heat conductive layer, which is located above the ink chamber and  
insulated from the heater and the conductor, the heat conductive layer  
thermally contacting the substrate and the metal layer.

11. The printhead as claimed in claim 10, wherein the heat  
conductive layer is made of any one of a material selected from the group  
consisting of aluminum, aluminum alloy, gold, and silver.

12. A method for manufacturing a monolithic ink-jet printhead,  
comprising:

(a) preparing a substrate;

(b) sequentially stacking a plurality of passivation layers on the substrate and forming a heater and a conductor connected to the heater between adjacent passivation layers of the plurality of passivation layers;

(c) forming a lower nozzle by etching to penetrate the plurality of passivation layers;

(d) forming a metal layer on the plurality of passivation layers, forming a hydrophobic coating layer exclusively on an outer surface of the metal layer, and forming an upper nozzle in communication with the lower nozzle by etching to penetrate the hydrophobic coating layer and the metal layer;

(e) etching an upper surface of the substrate exposed through the upper nozzle and the lower nozzle to form an ink chamber to be supplied with ink; and

(f) etching the substrate to form a manifold for supplying ink and an ink channel for providing communication between the ink chamber and the manifold.

13. The method as claimed in claim 12, wherein the substrate is made of a silicon wafer.

14. The method as claimed in claim 12, further comprising:  
forming a heat conductive layer which is located above the ink chamber, insulated from the heater and the conductor for thermally contacting the substrate and the metal layer between the passivation layers, during the sequentially stacking of the plurality of passivation layers on the substrate and the formation of the heater and the conductor.

15. The method as claimed in claim 14, wherein the heat conductive layer and the conductor are simultaneously formed from the same metal.

16. The method as claimed in claim 14, wherein the heat conductive layer is formed on the insulating layer after forming the insulating layer on the conductor.

17. The method as claimed in claim 14, wherein the heat conductive layer is made of any one material selected from the group consisting of aluminum, aluminum alloy, gold, and silver.

18. The method as claimed in claim 12, wherein forming the lower nozzle comprises dry etching the passivation layers within an area defined by the heater using reactive ion etching (RIE).

19. The method as claimed in claim 12, wherein forming the metal layer, forming the hydrophobic coating layer and forming the upper nozzle comprises:

forming a seed layer for electroplating on the plurality of passivation layers;

forming a plating mold for forming the upper nozzle on the seed layer;

forming the metal layer on the seed layer by electroplating;

forming the hydrophobic coating layer exclusively on the outer surface of the metal layer; and

removing the plating mold and the seed layer formed under the plating mold.

20. The method as claimed in claim 19, wherein forming the seed layer comprises depositing at least one material selected from the group consisting of titanium and copper on the plurality of passivation layers.

21. The method as claimed in claim 20, wherein the seed layer comprises a plurality of metal layers formed by sequentially stacking titanium and copper.

22. The method as claimed in claim 19, wherein forming the plating mold comprises depositing a layer selected from the group consisting of photoresist and a photosensitive polymer on the seed layer to a predetermined thickness and then patterning the deposited layer in a shape corresponding to a shape of the upper nozzle.

23. The method as claimed in claim 22, wherein forming the plating mold comprises patterning the deposited layer in a tapered shape, in which a cross-sectional area gradually increases in a downward direction, by a proximity exposure for exposing the deposited layer using a photomask which is installed to be separated from a surface of the deposited layer by a predetermined distance.

24. The method as claimed in claim 23, wherein an inclination of the plating mold is adjusted by varying a distance between the photomask and the deposited layer and by varying an exposure energy.

25. The method as claimed in claim 19, wherein the metal layer is formed of a material selected from the group consisting of nickel and copper.

26. The method as claimed in claim 19, wherein the metal layer is formed to a thickness of about 30-100  $\mu\text{m}$ .

27. The method as claimed in claim 19, wherein the hydrophobic coating layer is made of at least one material selected from the group consisting of a fluorine-containing compound and a metal.

28. The method as claimed in claim 27, wherein the fluorine-containing compound comprises a material selected from the group consisting of polytetrafluoroethylene (PTFE) and fluorocarbon.

29. The method as claimed in claim 28, wherein forming the hydrophobic coating layer comprises compositely plating PTFE and nickel on the surface of the metal layer.

30. The method as claimed in claim 29, wherein the PTFE and nickel are compositely plated to a thickness of about 0.1  $\mu\text{m}$  to several  $\mu\text{m}$ .



31. The method as claimed in claim 28, wherein forming the hydrophobic coating layer comprises depositing fluorocarbon on the surface of the metal layer using a plasma enhanced chemical vapor deposition (PECVD) process.

32. The method as claimed in claim 31, wherein fluorocarbon is deposited to a thickness of several angstroms to hundreds of angstroms.

33. The method as claimed in claim 27, wherein the metal is gold (Au).

34. The method as claimed in claim 33, wherein forming the hydrophobic coating layer comprises depositing gold on the surface of the metal layer using an evaporator.

35. The method as claimed in claim 34, wherein gold is deposited to a thickness of about 0.1-1  $\mu\text{m}$ .

36. The method as claimed in claim 12, wherein forming the ink chamber comprises isotropically dry etching the substrate exposed through the nozzle.

37. The method as claimed in claim 12, wherein forming the manifold and the ink chamber comprises etching a lower surface of the substrate to form the manifold; and

etching to penetrate the substrate between the manifold and the ink chamber to form the ink channel.